

¹ *Supplementary materials for: Fitness tracking reveals
task-specific associations between memory, mental
health, and exercise*

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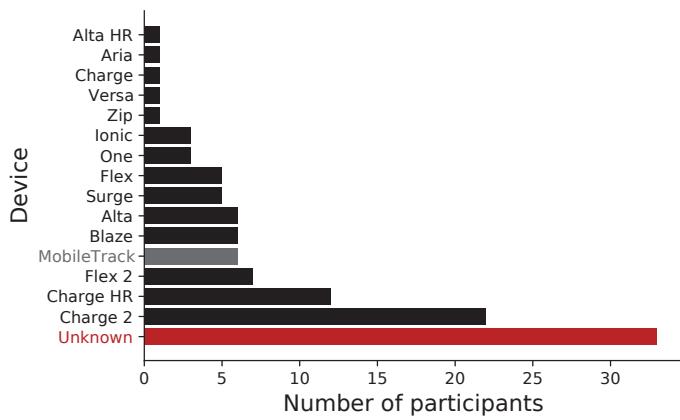


Figure S1: **Fitbit devices.** The bars indicate the numbers of participants whose fitness tracking data came from each model of Fitbit device. “MobileTrack” refers to participants who used smartphone accelerometer information to track their activity via the Fitbit smartphone app. “Unknown” denotes participants whose device information was not available from their available Fitbit data.

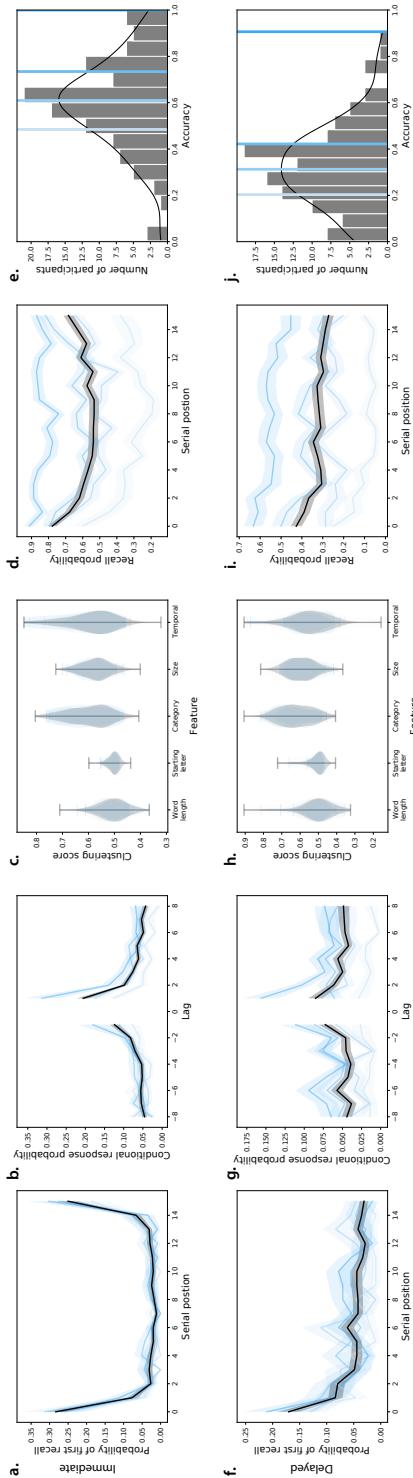


Figure S2: Free recall behavioral results. a–e. Immediate free recall. a. Probability of first recall. Probability of recalling each studied word first, as a function of its presentation position. b. Lag Conditional Response Probability. Probability of recalling the word presented at position $i + \text{Lag}$ following the recall of the word presented at position i . c. Clustering scores. Each score denotes participants' tendencies to successively recall (cluster) words according to the given feature dimension (Polyn et al., 2009); word length, starting letter, (semantic) category, size (large or small), or presentation position (temporal). d. Serial position curve. Probability of recalling each word as a function of its presentation position. e. Recall accuracy. Distribution of the average proportions of recalled words, across all lists studied by each participant. f–j. Delayed free recall. These panels are in the same formats as Panels a – e, but they reflect performance on the delayed free recall memory tests. All panels; error bars and error ribbons denote bootstrap-estimated 95% confidence intervals. Shading (saturation) denotes results for different subsets of participants, according to the average proportion of words they remembered (group boundaries are indicated by the colored lines in Panels e and j).

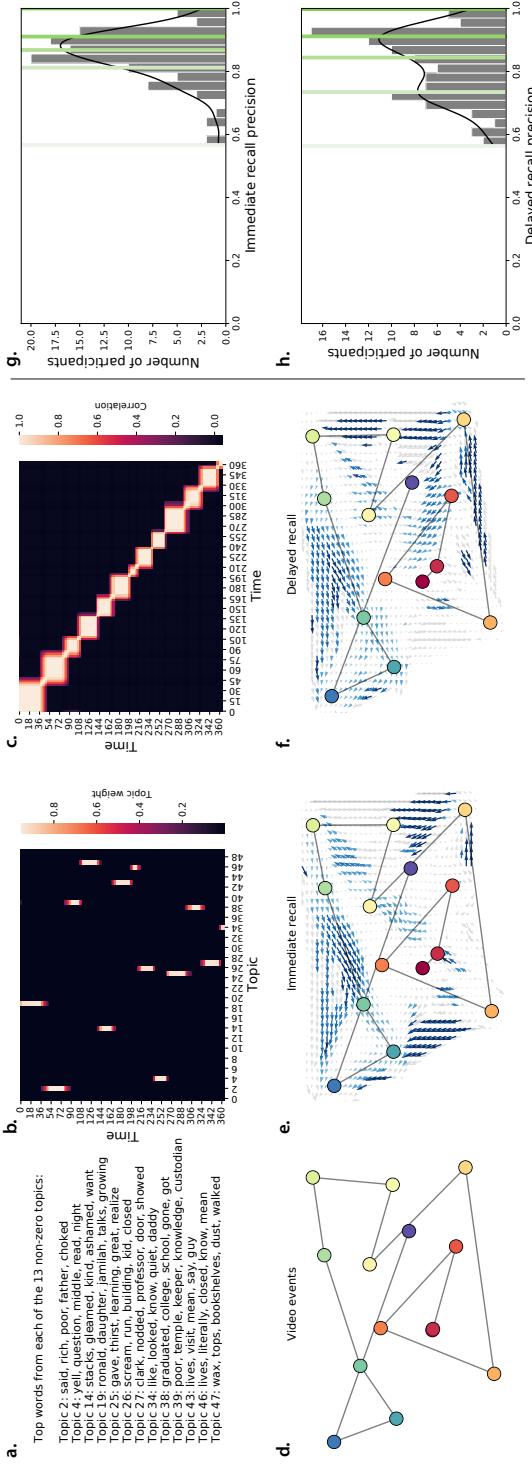


Figure S3: Naturalistic recall behavioral results. **a. Identified topics.** Applying a topic model to a series of sliding windows of the video’s transcript (Heusser et al., 2021) revealed a set of 13 unique (non-trivial) topics. The Panel displays the 5 top-weighted words from each topic. **b. Topic timecourse of the video.** Each row displays the topic weights for a single moment of the video. **c. Topic correlation matrix.** The correlations between the topic vectors for each pair of moments from the video reveals an event-like block diagonal structure. **d. Video topic trajectory.** The topic video’s topic timecourse (Panel b) has been projected onto 2-dimensions using Uniform Manifold Approximation and Projection (UMAP; McInnes et al., 2018). Each colored dot reflects an event, identified by applying a Hidden Markov Model to the video’s topic timecourse (Baldassano et al., 2017; Heusser et al., 2021). Red dots denote earlier timepoints in the video and blue dots denote later timepoints. **e. Immediate recall trajectory.** The black curve displays the average topic timecourse (projected into 2D using UMAP), obtained by applying the topic model shown in Panel A to the participants’ written transcripts from the immediate recall test. The arrows denote agreement across participants in the directions of their topic trajectories, for participants whose trajectories intersected the corresponding region of topic space. Blue arrows denote reliable agreement across participants ($p < 0.05$, corrected). **f. Delayed recall trajectory.** This panel is in the same format as Panel e, but displays the trajectory for participants’ delayed recall of the video. **g. Immediate recall precision.** Distribution of average recall precision, across all of the events each participant recalled during the immediate recall test. Precision is defined as the correlation between the topic vector for a given recalled event and the best-matching (most highly correlated) video event’s topic vector (Heusser et al., 2021). **h. Delayed recall precision.** This panel is in the same format as Panel g, but displays the average precision values for the delayed memory test.

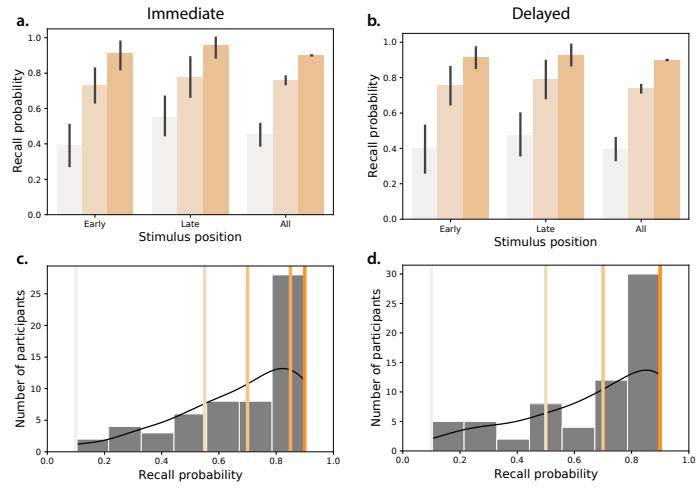


Figure S4: Foreign language vocabulary learning behavioral results. **a.** Immediate recall....

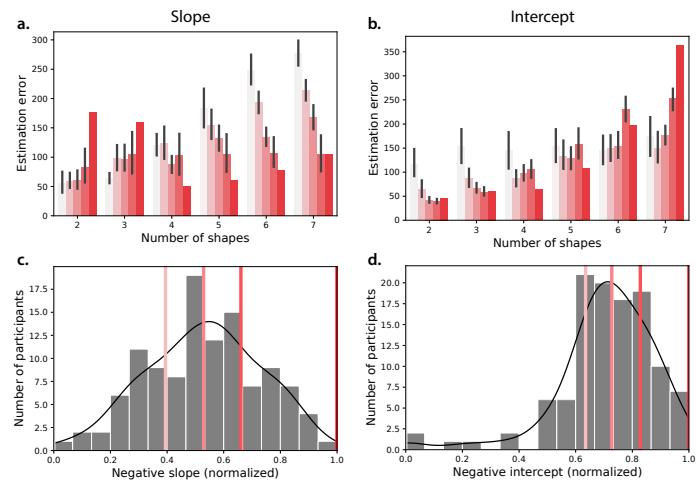


Figure S5: Spatial learning behavioral results.

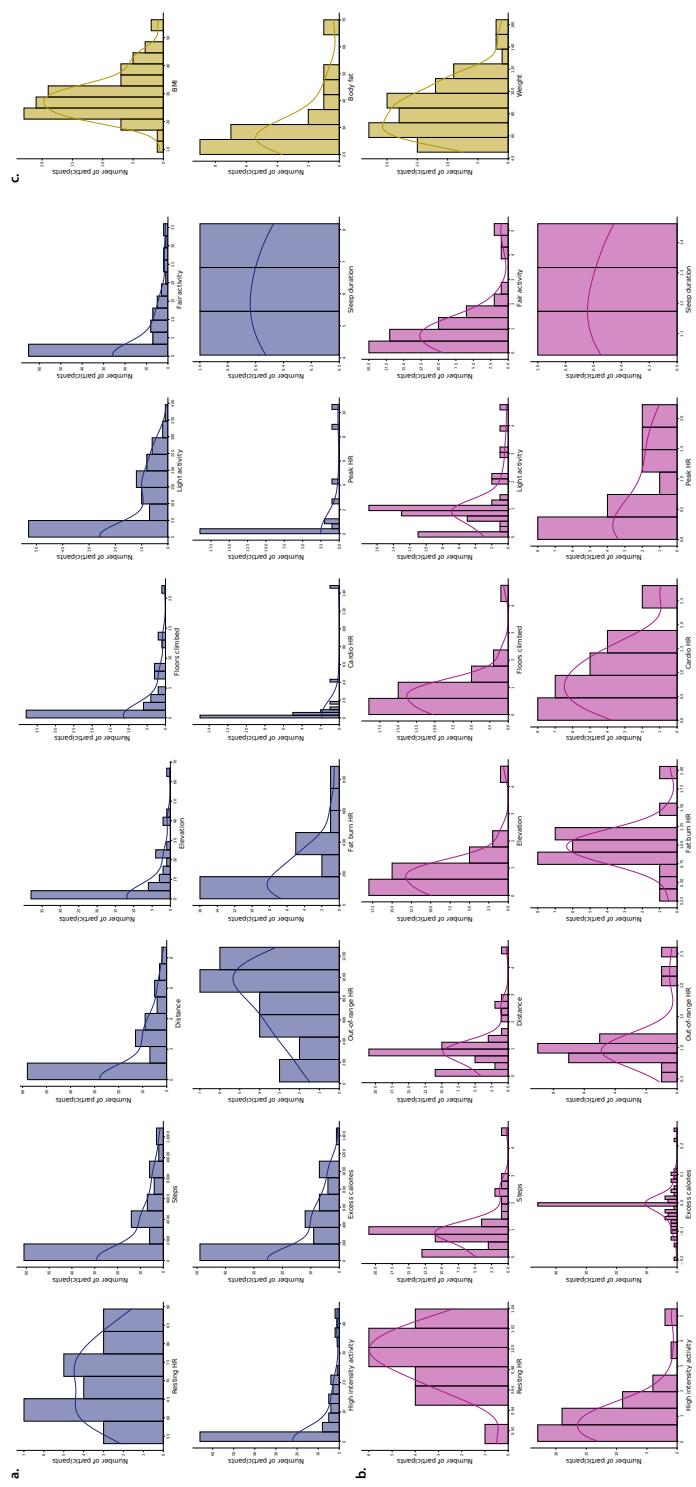


Figure S6: Distributions of fitness measures.

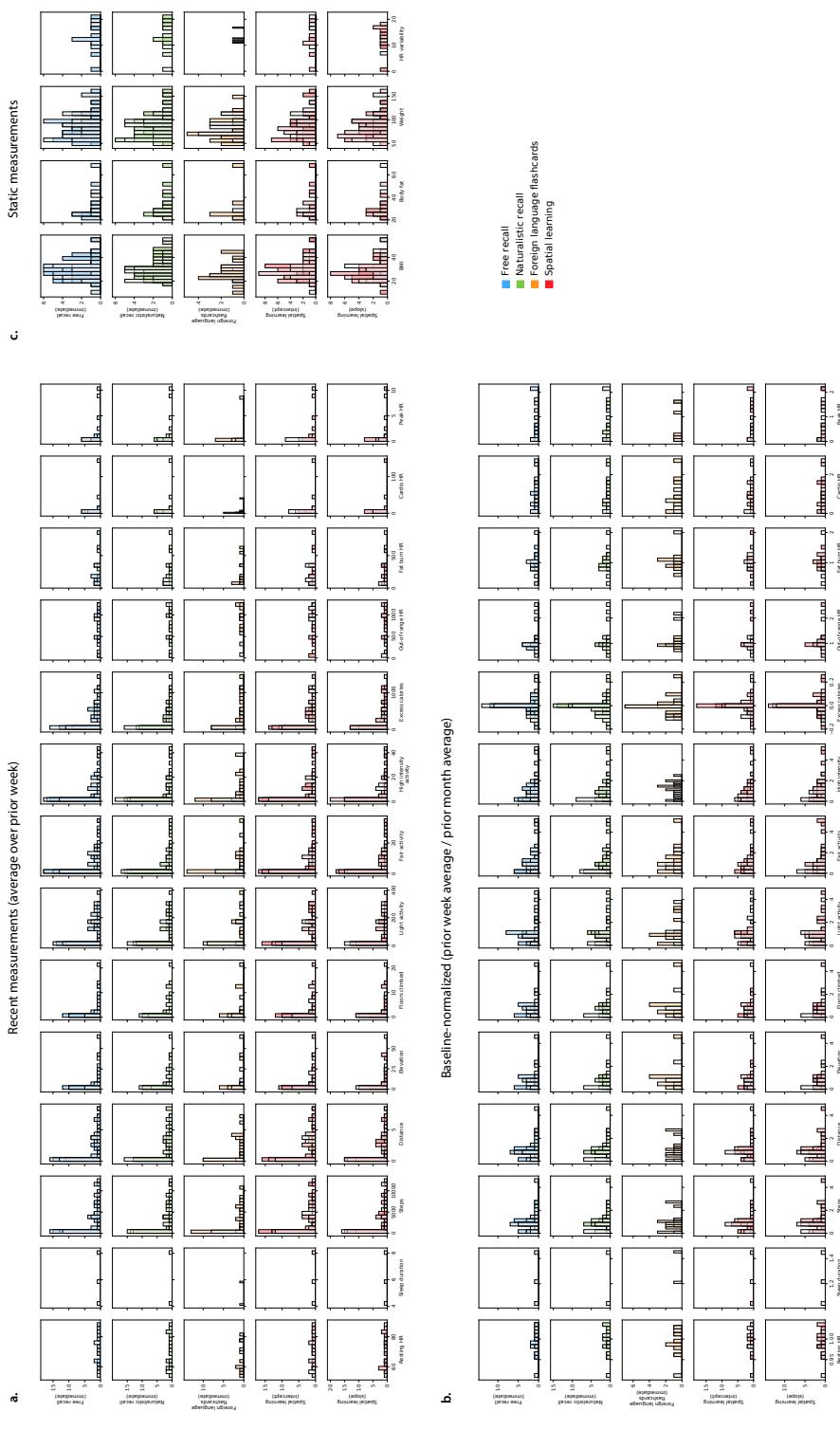
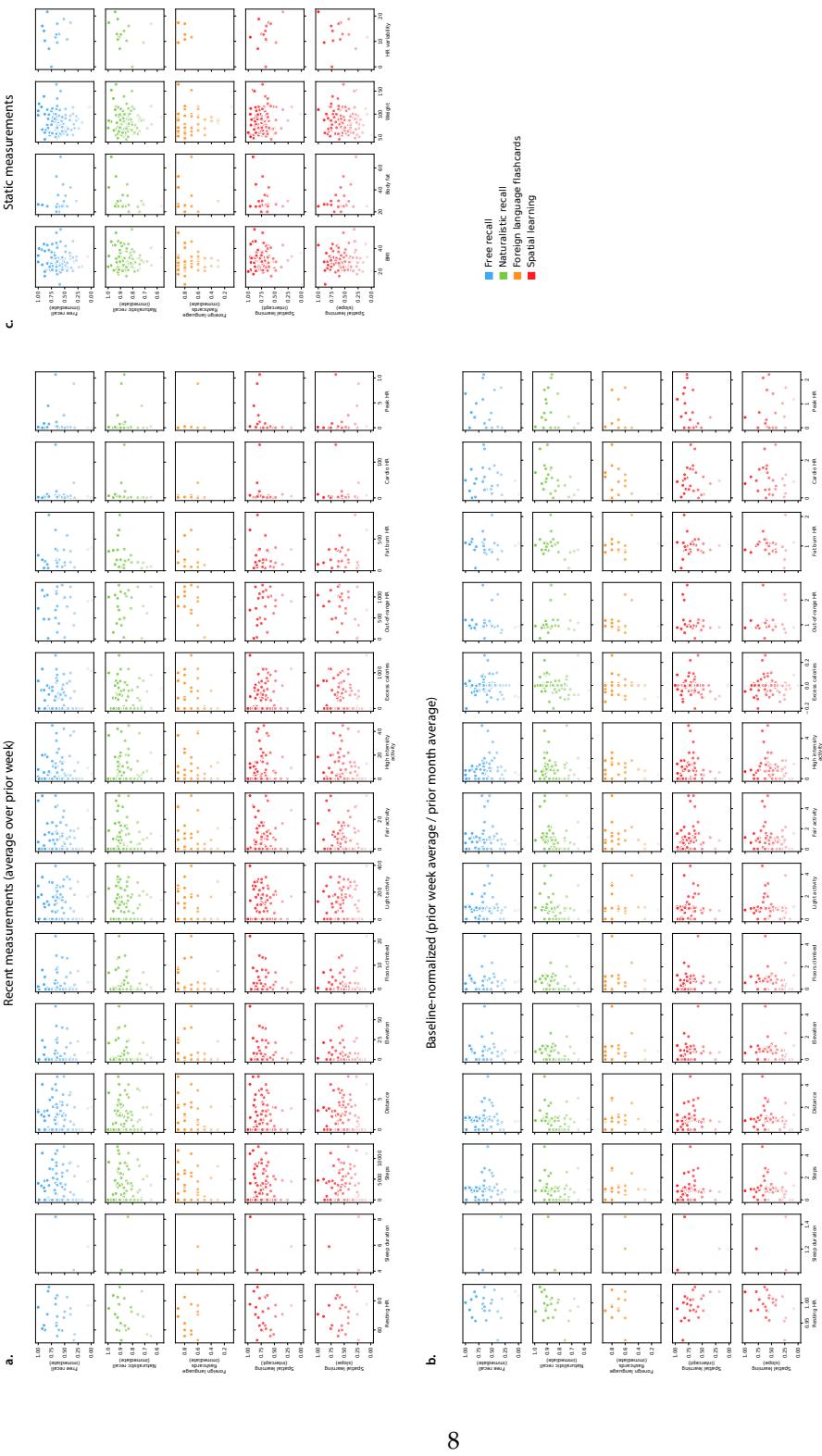


Figure S7: Distributions of fitness measures, broken down by immediate task performance.

Figure S8: Scatterplots of fitness measures versus immediate task performance measures.



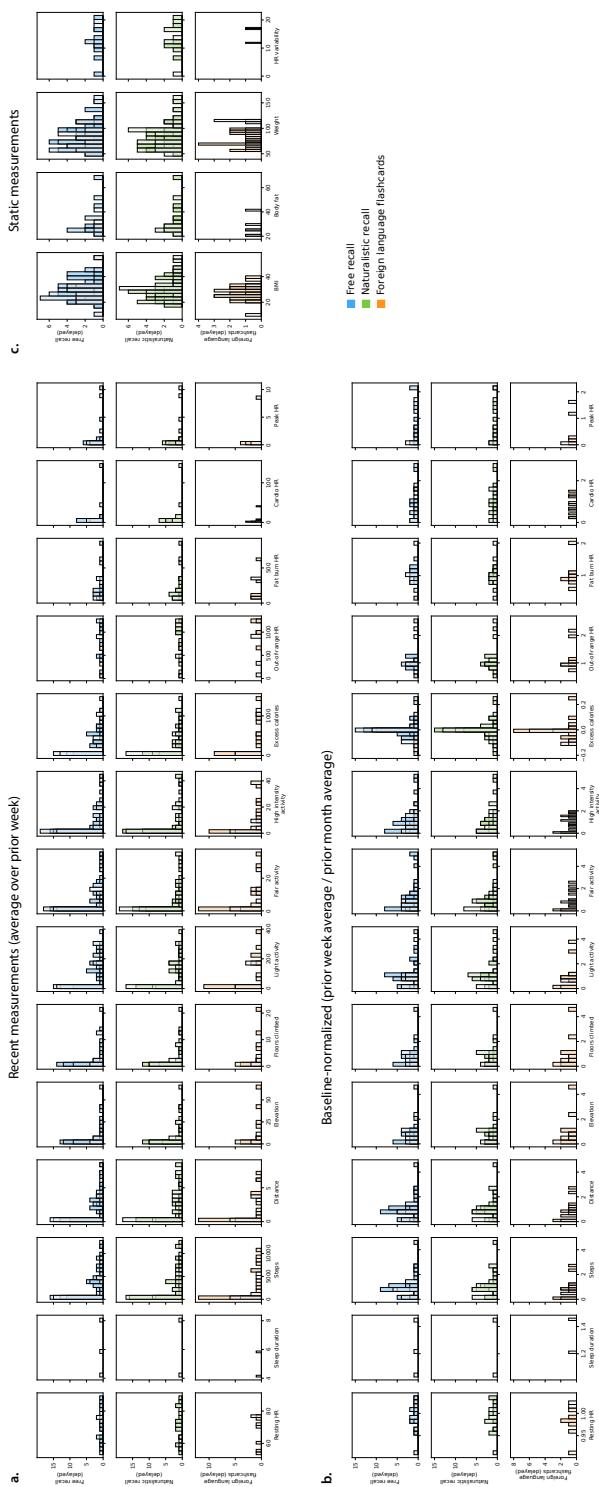


Figure S9: Distributions of fitness measures, broken down by delayed task performance.

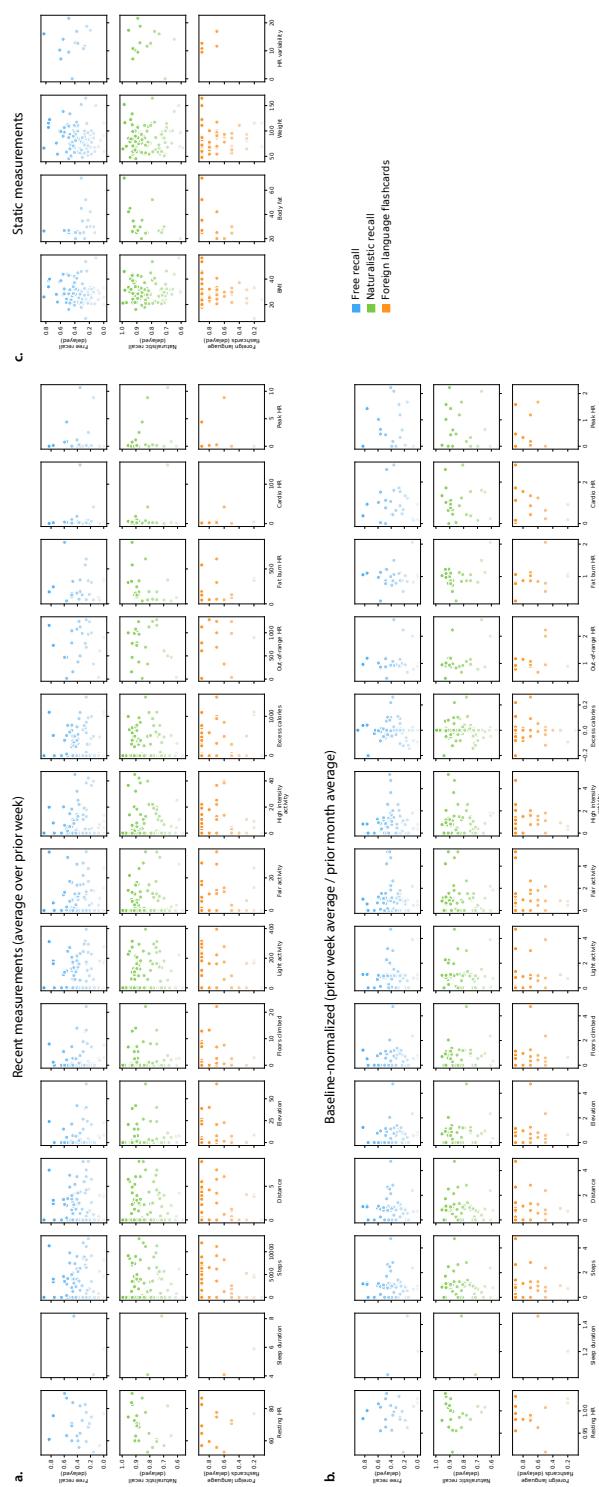


Figure S10: Scatterplots of fitness measures versus delayed task performance measures.

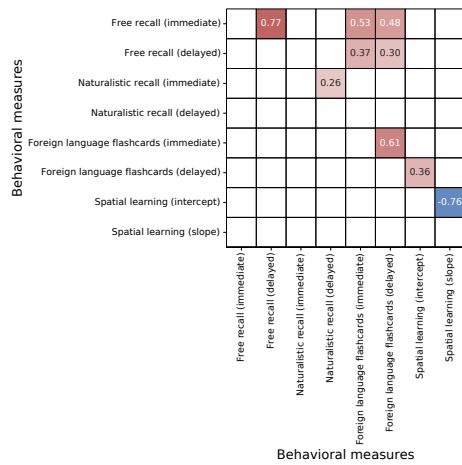


Figure S11: Bootstrap-estimated reliable correlations between behavioral measures.

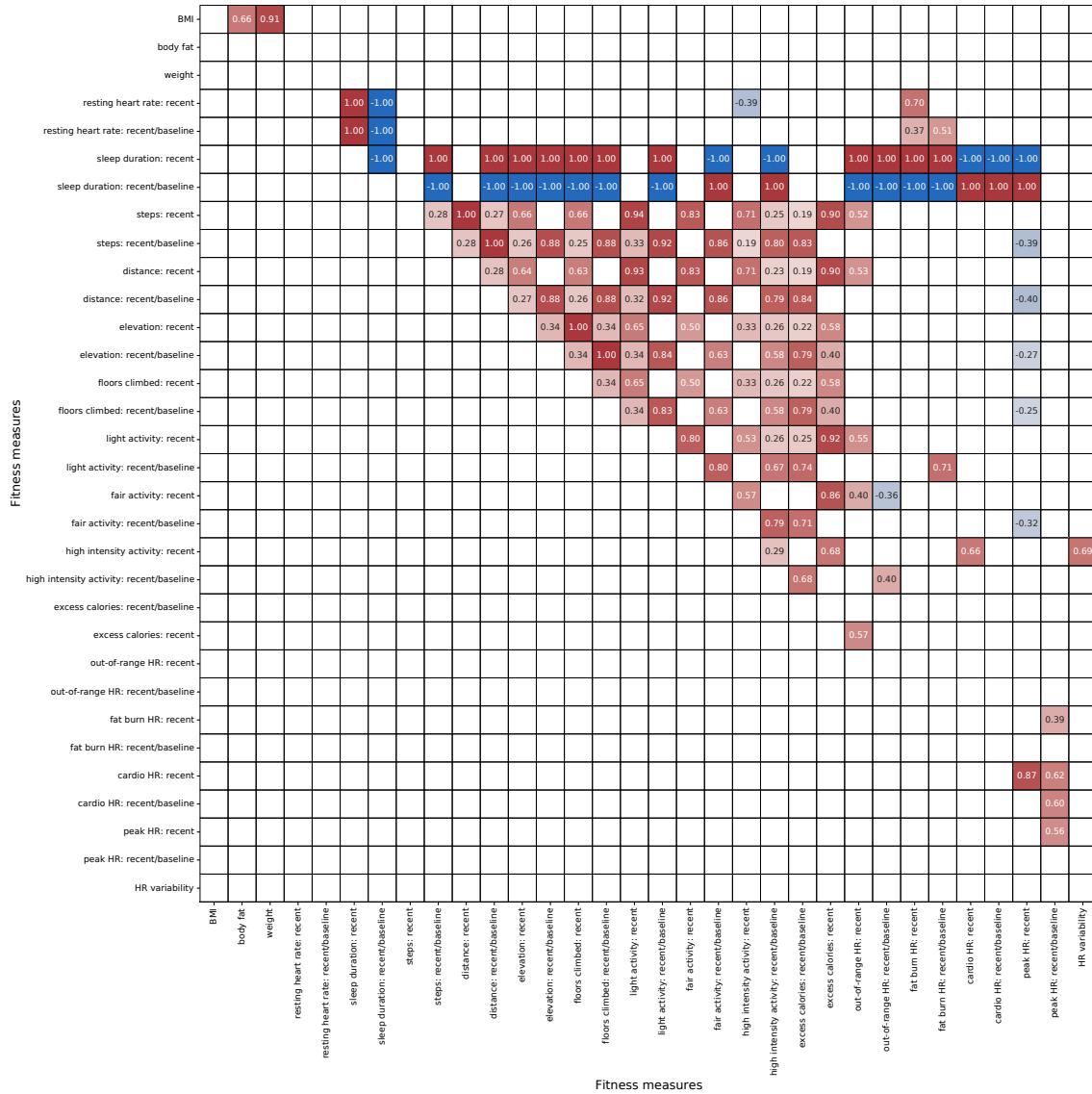


Figure S12: Bootstrap-estimated reliable correlations between fitness measures.

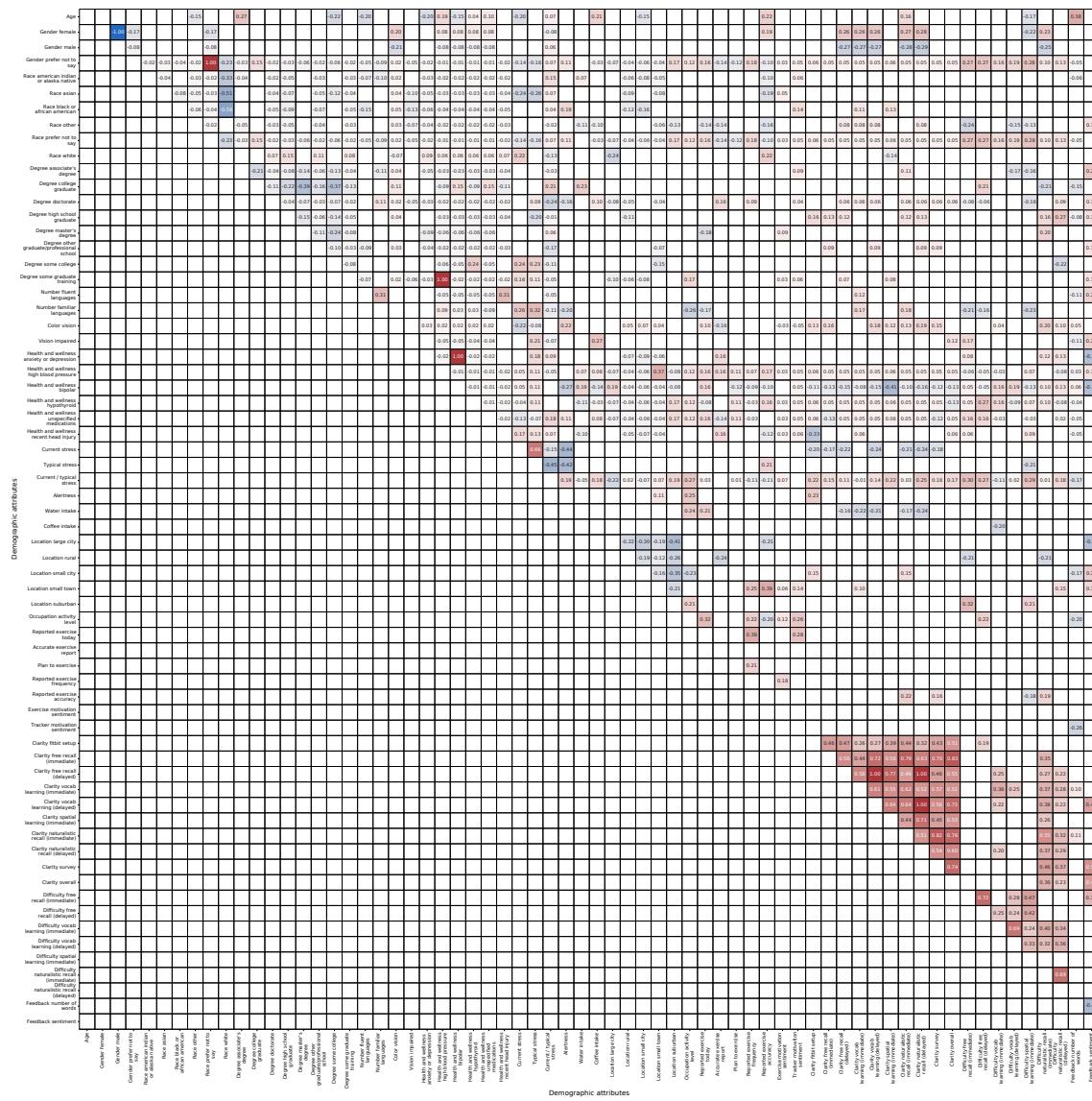


Figure S13: Bootstrap-estimated reliable correlations between demographic measures.

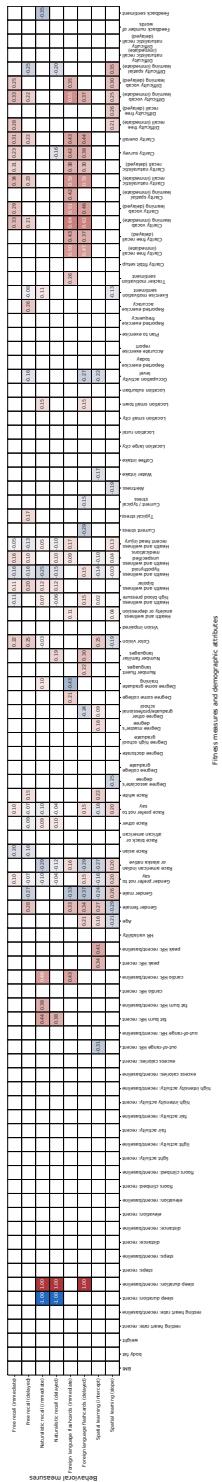


Figure S14: Bootstrap-estimated reliable correlations between behavioral measures and fitness or demographic measures.

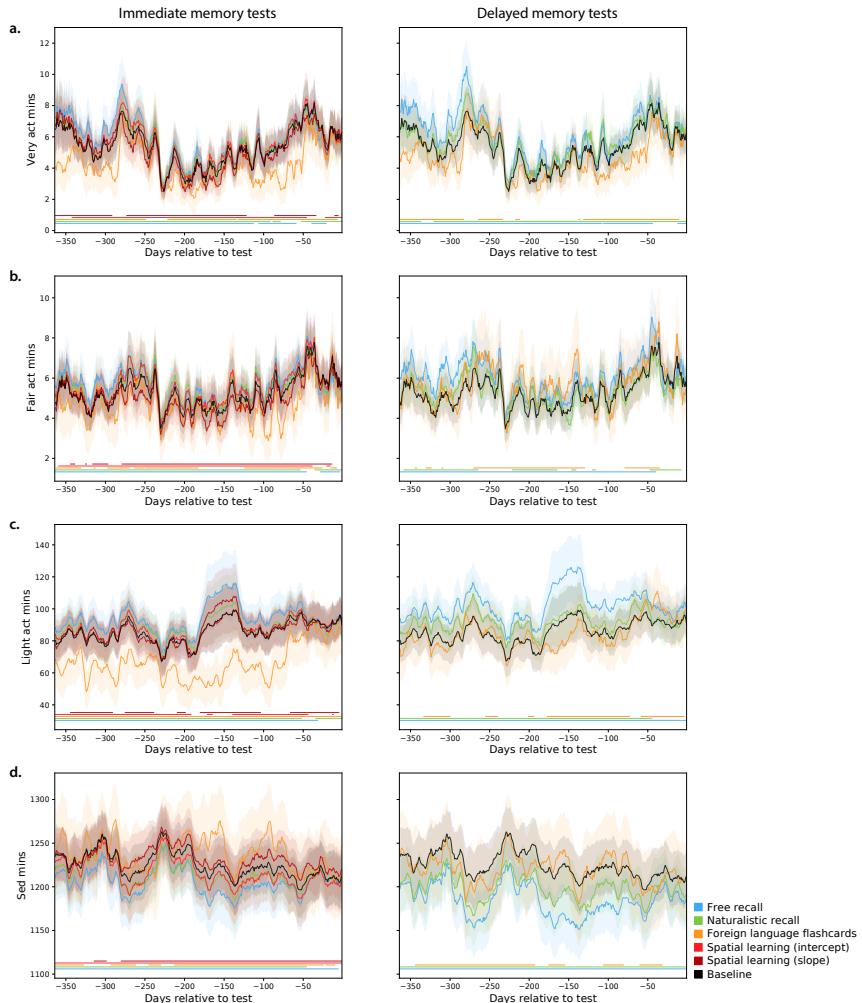


Figure S15: History of fitness activity levels weighted by behavioral performance.

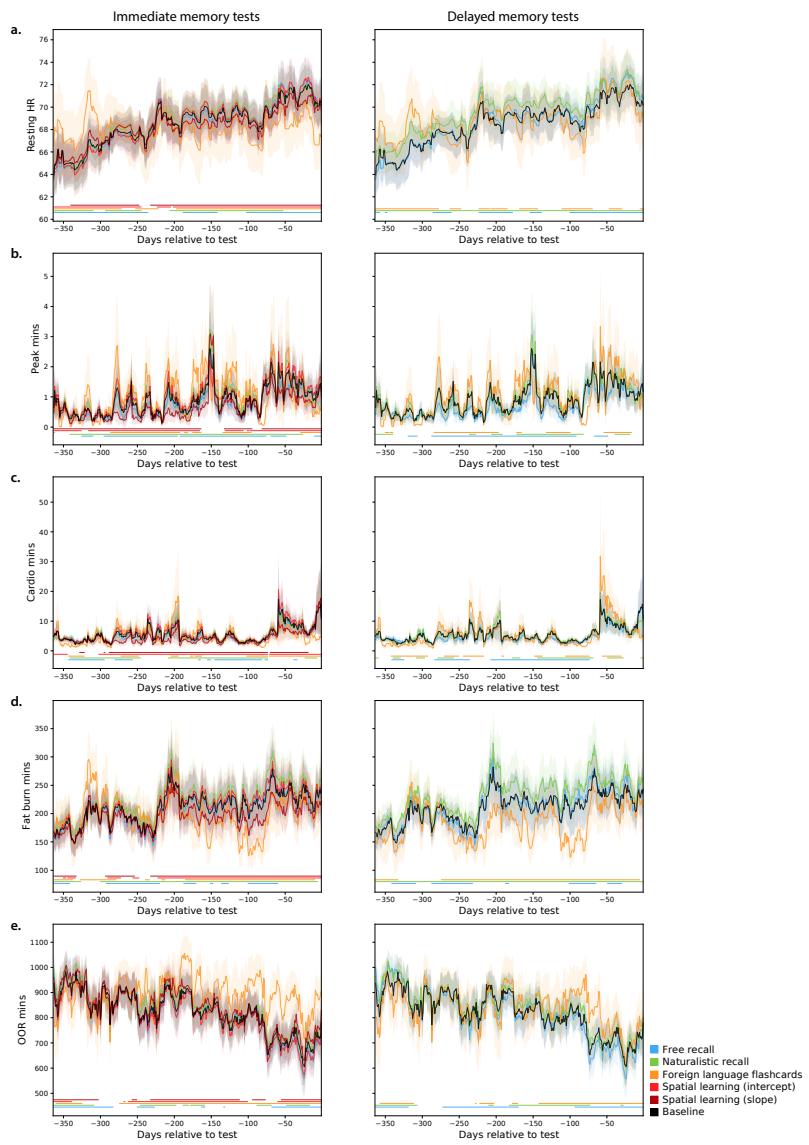


Figure S16: History of cardiovascular activity weighted by behavioral performance.

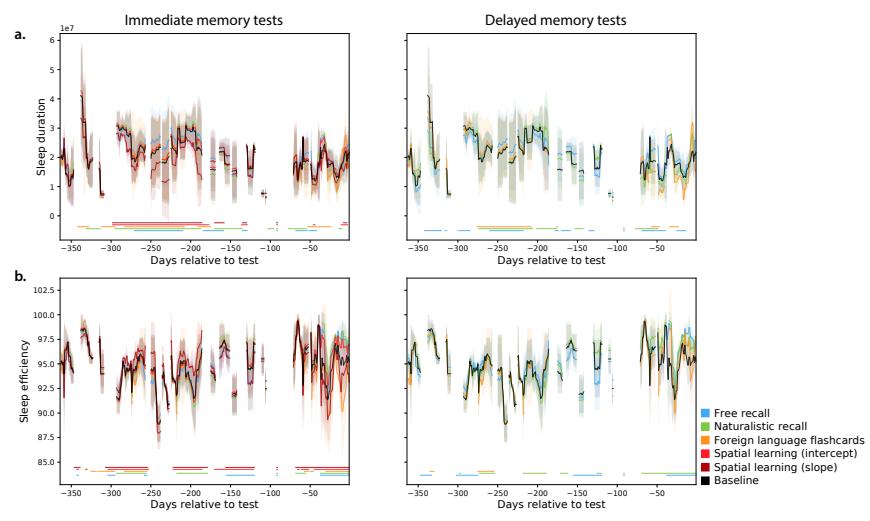


Figure S17: History of sleep efficiency and duration weighted by behavioral performance.

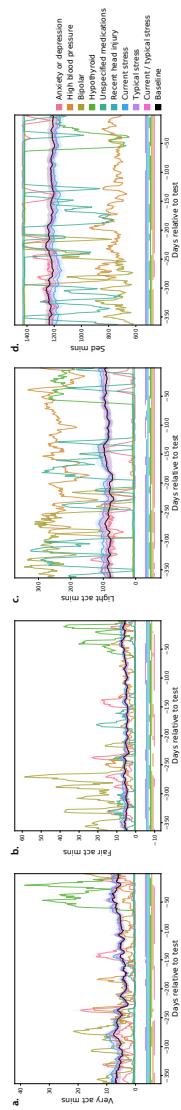


Figure S18: History of fitness activity levels weighted by mental health factors.

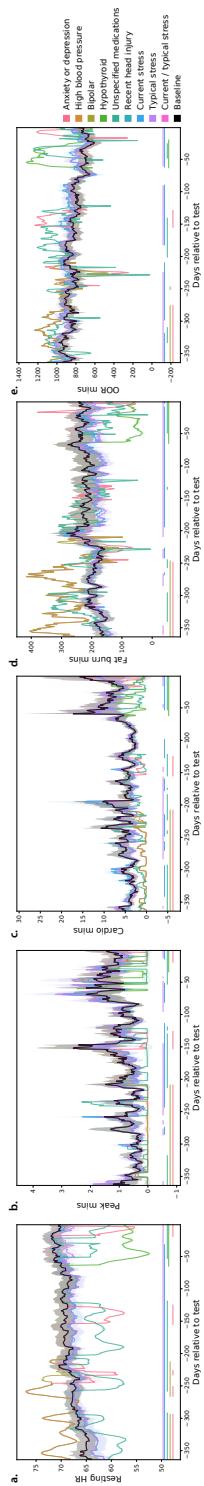


Figure S19: History of cardiovascular activity weighted by mental health factors.

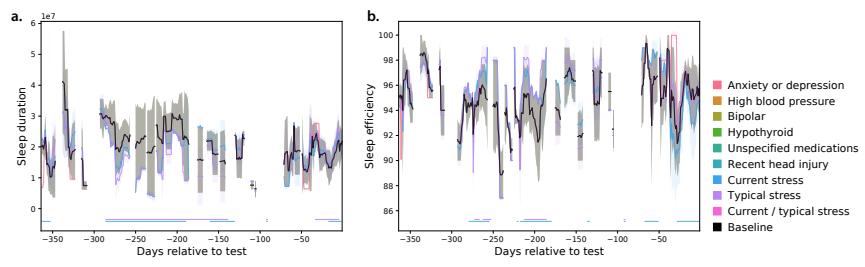


Figure S20: History of sleep efficiency and duration weighted by mental health factors.

⁹ References

- ¹⁰ Baldassano, C., Chen, J., Zadbood, A., Pillow, J. W., Hasson, U., and Norman, K. A. (2017).
¹¹ Discovering event structure in continuous narrative perception and memory. *Neuron*, 95(3):709–
¹² 721.
- ¹³ Heusser, A. C., Fitzpatrick, P. C., and Manning, J. R. (2021). Geometric models reveal behavioral
¹⁴ and neural signatures of transforming naturalistic experiences into episodic memories. *Nature Human Behavior*, In press.
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- ¹⁶ McInnes, L., Healy, J., and Melville, J. (2018). UMAP: uniform manifold approximation and
¹⁷ projection for dimension reduction. *arXiv*, 1802(03426).
- ¹⁸ Polyn, S. M., Norman, K. A., and Kahana, M. J. (2009). Task context and organization in free recall.
¹⁹ *Neuropsychologia*, 47:2158–2163.